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Certification and operations and maintenance activities: a virtuous relationship

La certificación y las actividades de operaciones y mantenimiento: una relación virtuosa

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Abstract

Improving safety in transport aviation in recent decades requires continuous evaluation of existing processes to identify areas for improvement in accident prevention, understanding of causes and rectification measures.

Resumen

La mejora de la seguridad en la aviación de transporte de las últimas décadas requiere una evaluación continua de los procesos existentes para identificar áreas de mejora en la prevención de los accidentes, en la comprensión de las causas y en las medidas de rectificación.

Interfaces

Recent aeronautical events emphasize the complex nature of accident prevention and the importance of understanding and improving processes related to the interfaces between certification and operational and maintenance activities.

Two cases are briefly presented as examples:

1. Alaska Airlines Flight 261 Accident[1]

The McDonnell Douglas MD-83 aircraft experienced an in-flight loss of control, followed by a nosedive, with documented failures in the maintenance of the control of the trim or longitudinal control compensation system.

The United States National Transportation Safety Board (NTSB) considered several potential causes, including maintenance practices. The analysis of the stabilizer nut revealed that the components were not lubricated, leading to excessive thread wear.

The investigation also identified systemic supervision issues in maintenance programs, the approval process for maintenance interval extensions, and compliance with certification requirements by the aviation authority.

2. Lion Air Flight 610[2] and Ethiopian Airlines Flight 302[3] Accidents

A typical example of the interfaces between aircraft certification and operational and maintenance activities is the case of the Boeing 737 MAX.

These aircraft accidents occurred within a span of five months. The investigative committee identified, among other events, failures in the certification process and the operational evaluation of the aircraft.

The flight crews had not been informed or trained on Boeing's new system, the Maneuvering Characteristics Augmentation System, known by its acronym MCAS. It is an automatic system that receives information from Angle of Attack (AOA) sensors located on the aircraft's nose and acts on the horizontal stabilizer.

The installed software was designed to prevent uncommanded increases in angles of attack caused by engine thrust effects. A system failure erroneously activated MCAS, leading to a series of cascading effects that created extreme situations for longitudinal control of the aircraft.

Boeing did not consider it necessary to modify the aircraft's Flight and Operations Manuals, nor did it inform pilots about the existence of this system, as they believed it should not significantly alter operational handling. There was also no formal training program to familiarize pilots with the differences between the old and new Boeing models.

As a result of these accidents, the operation of the Boeing 737 MAX was suspended, and a recertification process began with the involvement of experts from the United States Federal Aviation Administration (FAA), the Canadian Civil Aviation Authority (TCCA), the European Union Aviation Safety Agency (EASA), and the Brazilian National Civil Aviation Agency (ANAC).

The items analyzed in the validation process were:

- Aircraft software.
- Flight crew procedures.
- Flight and maintenance instructions.
- Required maintenance.
- Flight simulator.
- Master Minimum Equipment List (MMEL).
- Certification regulations.

Operational Aircraft Evaluation

It is an integrated process that should be carried out by aviation authorities for a new aircraft model that requires a type rating for its operation or for an already certified model when modifications are introduced. This task should be performed by groups of specialists in certification in the areas of engineering, flight crew, cabin crew, and maintenance.

The objectives of this process are as follows:

- Evaluate all elements related to compliance with operational standards, including operational suitability with a special emphasis on normal, abnormal, and emergency procedures, as well as all operational documentation.

- Establish the prerequisites for flight crews, including their prior experience.

- Define the type rating requirements needed for the operation of the aircraft.

- Determining operational similarity with the

1. Accident occurred in January 2000 with 89 fatal victims.
2. Accident occurred in October 2018 with 189 fatal victims.
3. Accident occurred in March 2019 with 157 fatal victims.

previously certified aircraft model, when applicable.

- Providing difference requirements for the crews when necessary.
- Recommend Standard Operational Procedures (SOPs) for the new or modified aircraft model.
- Recommending minimum standards in emphasized areas (e.g., Flight Management System - FMS, Electronic Checklist, all-weather/ low-visibility operations - LVO, etc.).
- Determining applicable requirements for pilot training, proficiency exams, and suitability maintenance.
- Analyzing aircraft compliance with operating standards according to current regulations, such as the Argentine Civil Aviation Regulations (RAAC) Parts 91[4], 121[5], and 135[6], in the case of Argentina.
- Defining the characteristics of devices used in pilot training, whether it is Flight Simulation Training Devices (FSTD), Full Flight Simulators (FFS), Flight Training Devices (FTD), or devices used for theoretical knowledge enhancement.
- Use of equipment or functions such as Electronic Flight Bag (EFB), Head-Up Display (HUD), Enhanced Vision System (EVS), etc.
- Recommending training for the certification staff in the maintenance area.
- Approving the Master Minimum Equipment List (MMEL).
- Evaluating technical and flight characteristic improvements that manufacturers incorporate into production aircraft (e.g., increased operational ceiling, equipment integration, Reduced Vertical Separation Minimum - RVSM, integration of autothrottle[7] into the autopilot system, etc.).

Additionally, if applicable:

- Recommend minimum training standards and the respective area of emphasis, verification of competences, and validity of cabin crew members (including difference training requirements).

The results of the aircraft's operational evaluation processes should be published on the aeronautical authority's website as an Operational Evaluation Report. This report serves as a reference for the certification processes of air service operators, approved training organizations, and aeronautical personnel certification, among others.

Flight evaluations to validate the aircraft type certificate:

These are tests conducted for the purpose of demonstrating or verifying compliance with applicable airworthiness standards to ensure that each aircraft conforms to its type design and is in a condition of safe operation.

The process begins with the participation of a team of specialists based on the technical complexity of the aeronautical product to be certified. It may cover areas such as structures, propulsion, systems and equipment, avionics, performance, in-service difficulties, continued airworthiness, and flight tests. The first step is to prepare a program of activities that includes flight evaluations.

Execution of flight tests

The flight test program generally consists of verifications of the most critical performance and flight characteristics. In addition, verifications of specific systems may be included in the program.

Analysis of the certification documentation or known aircraft background can raise suspicions about marginal compliance with certain requirements. This is why areas of doubt must be explored, and determinations must be made regarding the acceptability or non-acceptability of the matter or raise objections and discrepancies.

In some cases, significant modifications may be required, while in others, they may be of lesser magnitude, such as including information in operational publications. As an example, two cases are presented below.

1. The case of the validation of Boeing 707 in the United Kingdom (UK)

After conducting the analyses and certification flights, the Civil Aviation Authority of the United

4. Flight Rules and General Operation.
5. Requirements for Internal and International Regular Operations: Supplementary Operations.ts for Internal and International Non-Regular Operations.
7. Automatic Thrust Control System.

Kingdom (CAA) demanded the incorporation of a device that restores stability to acceptable levels in the flight control system to enhance low-speed stability with flaps extended. This aircraft does not exhibit any stability issues except in the fully extended flaps configuration during decelerations to certify the stall speed. During these deceleration maneuvers, uncommanded pitch-ups occur, which must be aggressively counteracted by the pilot to prevent reaching values that could compromise flight safety.

2. The case of the validation of McDonnell Douglas MD-88 in the Argentine Republic

During the validation process of the aircraft that would become part of Aerolíneas Argentinas' fleet, a formal request had to be made to the Federal Aviation Administration (FAA) to include a warning in the Flight Manuals about a significant instability phenomenon due to compressibility effects within the flight domain.

This phenomenon occurs at Mach 0.83 (maximum operational Mach 0.84), and at this speed, applying rudder input to one side (left or right) results in reverse induced rolls, contrary to what happens in the rest of the flight envelope.

The Manufacturer's Flight Manual did not provide any warning about this issue, which meant that flight crews were unaware of this anomalous behavior. After lengthy discussions, the FAA acknowledged that pilots should not be unaware of this phenomenon, and if they ever entered the range of these speeds, they should know how to apply the controls to exit such a situation. Eventually, the Flight Manual for Argentina was modified, and a warning about this phenomenon, known as "rudder reversal"[8] was added

CONCLUSIONS

Certification processes and their interfaces with aircraft operation and maintenance are specific responsibilities of aeronautical authorities and the industry. It is essential to broaden the perspective and strongly consider the lessons learned from past accidents.

The aviation industry is advancing rapidly, and aeronautical authorities have a duty to keep pace with this increasingly complex technological environment.

Moreover, to achieve significant improvements in reducing the accident rate, a better understanding of the issues affecting human performance is required. Manufacturers face the challenge of developing systems that are less prone to errors, and procedures must be more explicit and robust concerning the range of skills and techniques of operational personnel (including cabin crew) and maintenance staff.

8. This phenomenon is a high-speed characteristic inherent to the entire MD 80 family.